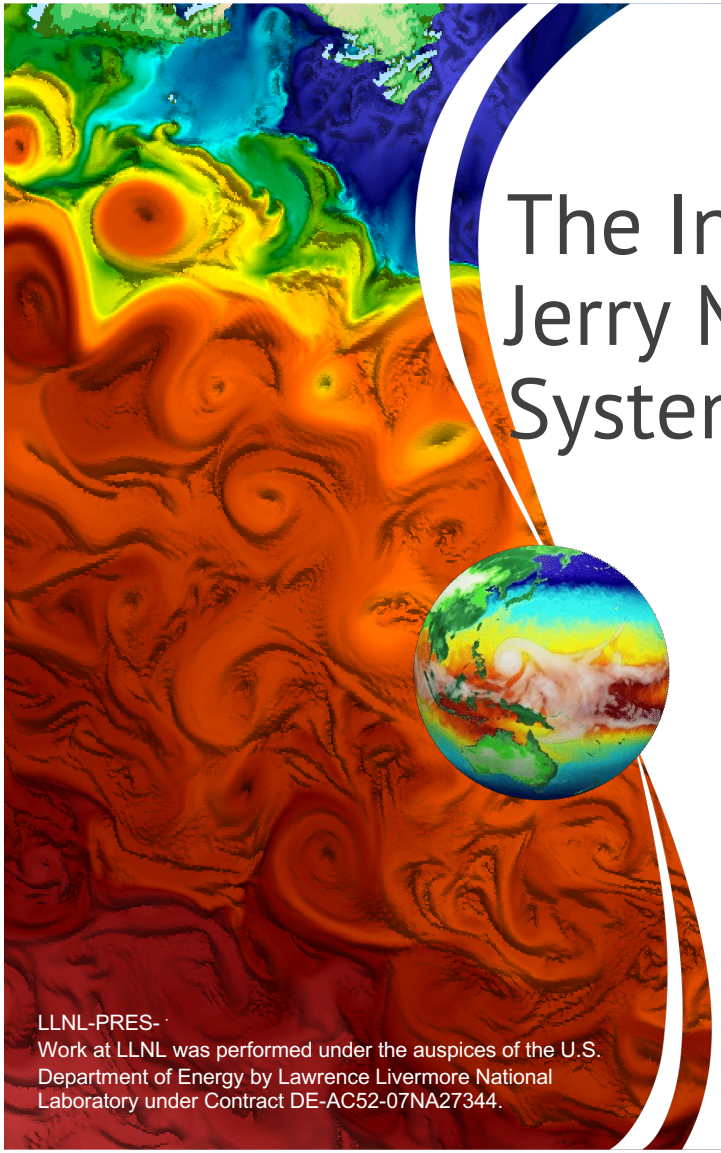


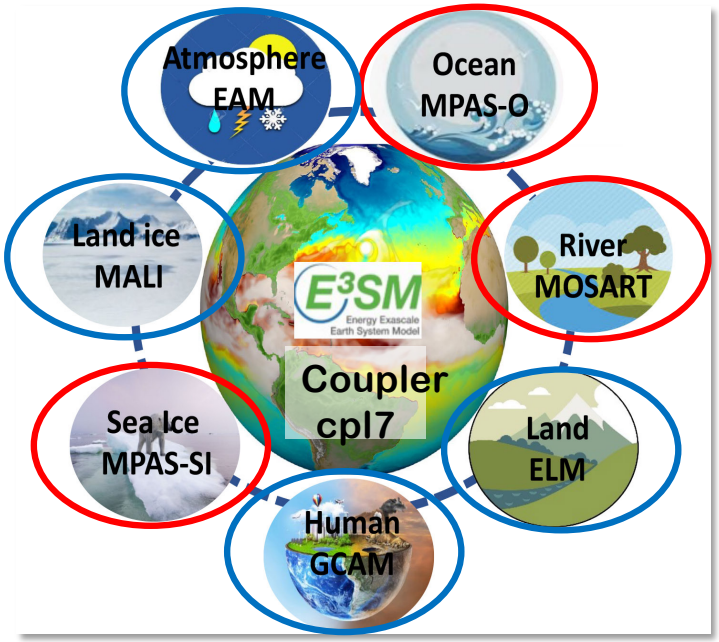
The Influence of Warren Washington and Jerry Meehl on the Energy Exascale Earth System Model Development Strategy

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2. Sandia National Laboratories
3. Pacific Northwest National Laboratory

LLNL-PRES-
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A DOE model for DOE science on DOE computers



Golaz, et al, 2018
Golaz, et al 2022
https://E3SM.org

The Energy Exascale Earth System (E3SM) Model Project

- Started as Project ACME in 2014
- Version 0 forked from CESM1
- Version 1 released in 2018
  - New and updated components
  - Standard (1°) and High (0.25°, Eddy-Resolving) resolutions
  - Climate metric and diagnostics mostly within range of 1 SD of CMIP 5
- Version 2 tagged in 2021
  - Computational throughput nearly doubled
  - Climate metrics substantially improved
  - Regional refinement capability in all components
- Version 3 tagged in 2024
  - New and substantially rewritten components
  - Historical global temperature bias virtually eliminated
- Simple Cloud-Resolving EAMv1 (SCREAMv1) tagged in 2023
  - Exascale ready
  - Base code for EAMv4

Coupled-system Model Tuning

Component-level tuning

- Ocean, sea-ice (G-cases)
- AMIP simulations (F-cases)
- Land (I-cases)

Coupled model tuning

Objectives

1. Near-zero long-term average net top-of-atmosphere energy flux.
2. Minimum long-term drift in global mean surface air temperature.
3. Reasonable absolute global mean surface air temperature.
4. Climate metrics.

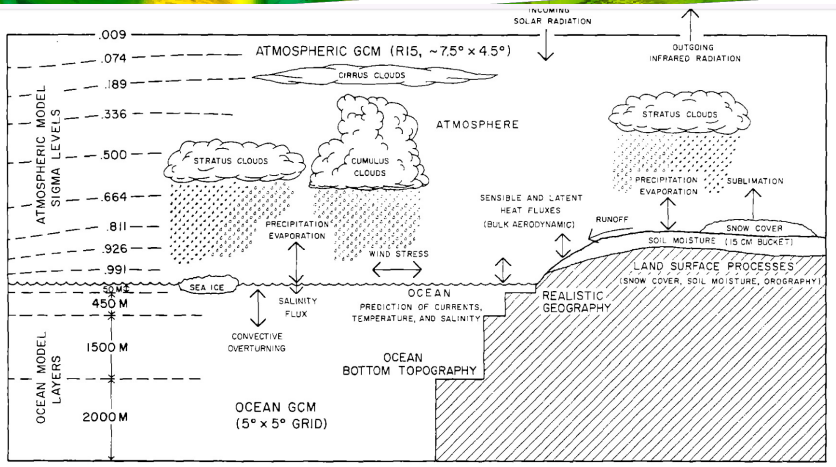


Fig. 1. Schematic of vertical-layer structure of coupled atmosphere/ocean model. Various physical processes and their interactions are depi

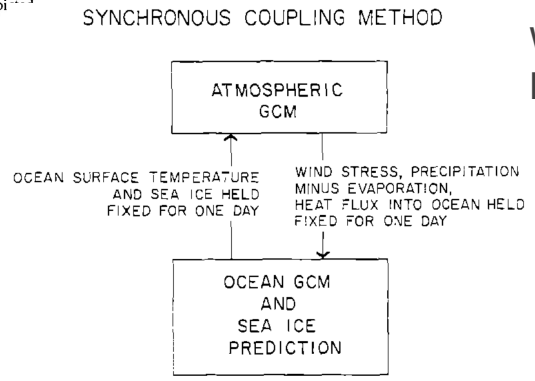


Fig. 2. Schematic of synchronous coupling method for atmospheric and oceanic sea-ice models

Washington and Meehl (1989)

Resolution and Advanced Computing

DOE Parallel Climate Model (PCM)

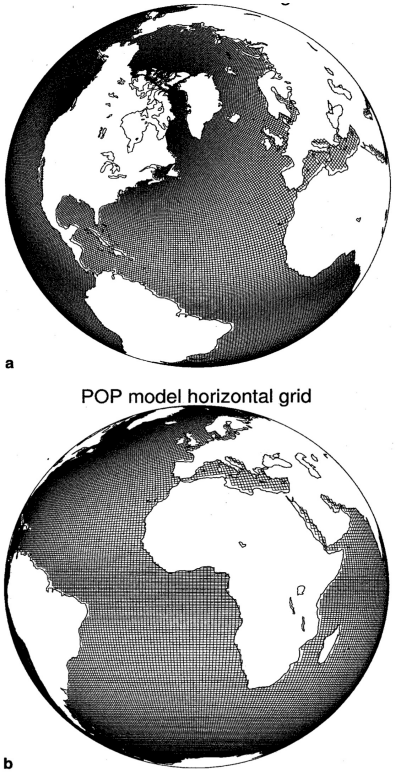


Fig. 1a, b Two views of the Parallel Ocean Program (POP) model horizontal grid at 2/3-degree resolution

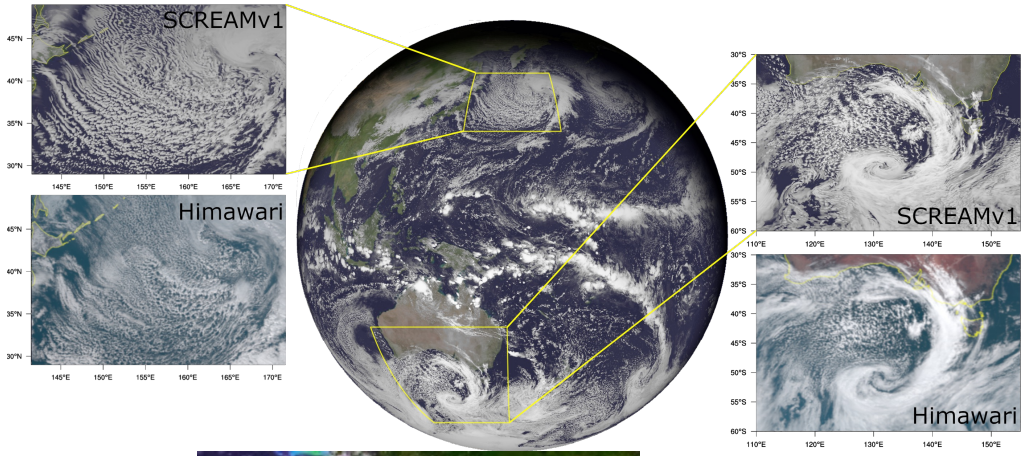
New Programming Models

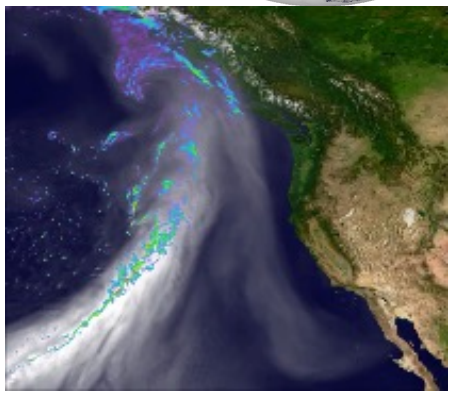
- PCM - MP-MPI,
- SCREAM -C++- Kokkos)

Exploit leading edge computing

- PCM- Petascale systems Distributed Memory
- SCREAM - Exascale CPU-GPU systems

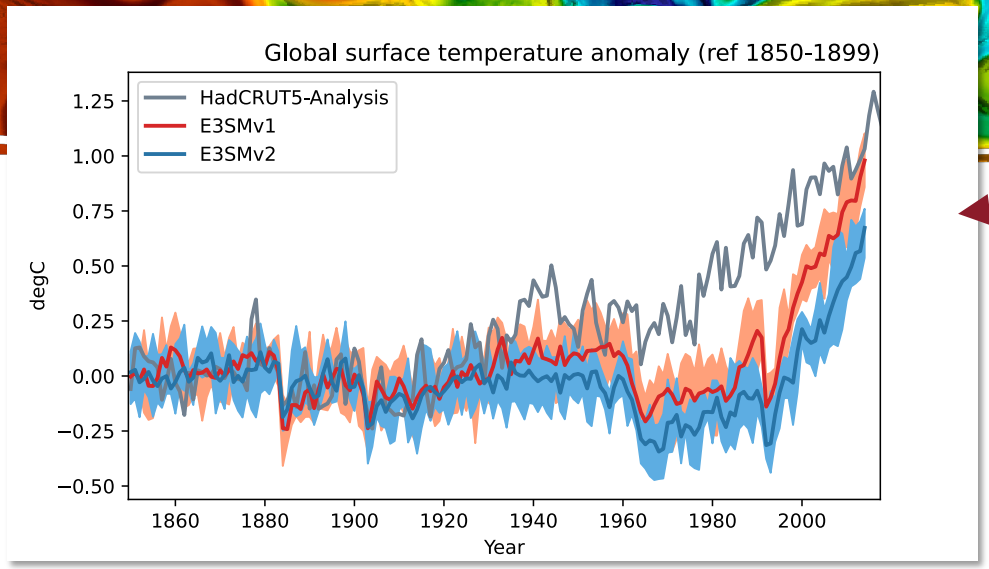
SCREAM-EAMxx_E3SMv4 Cloud resolving atmosphere model component

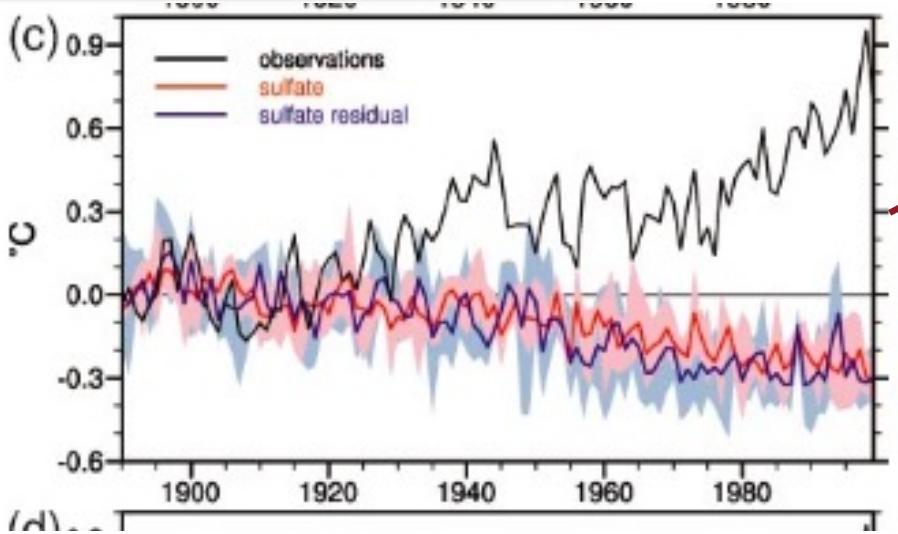


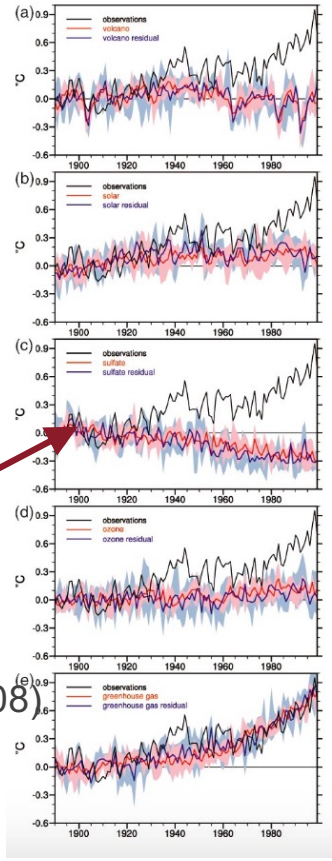


Donahue, et al (2024)

The “pothole” problem. [Not unique to E3SM]



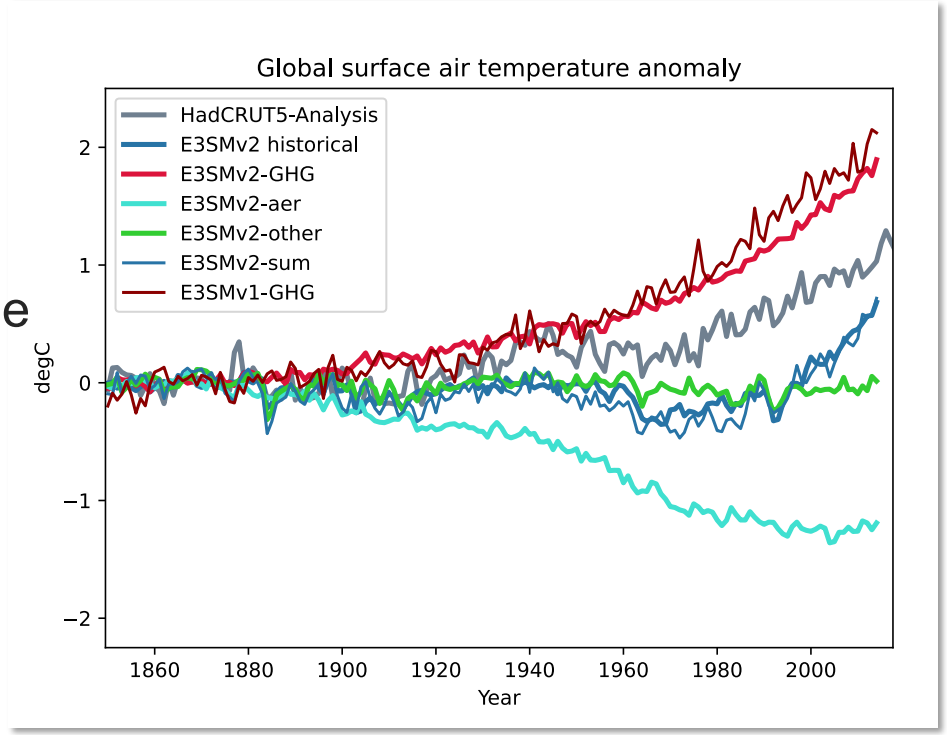




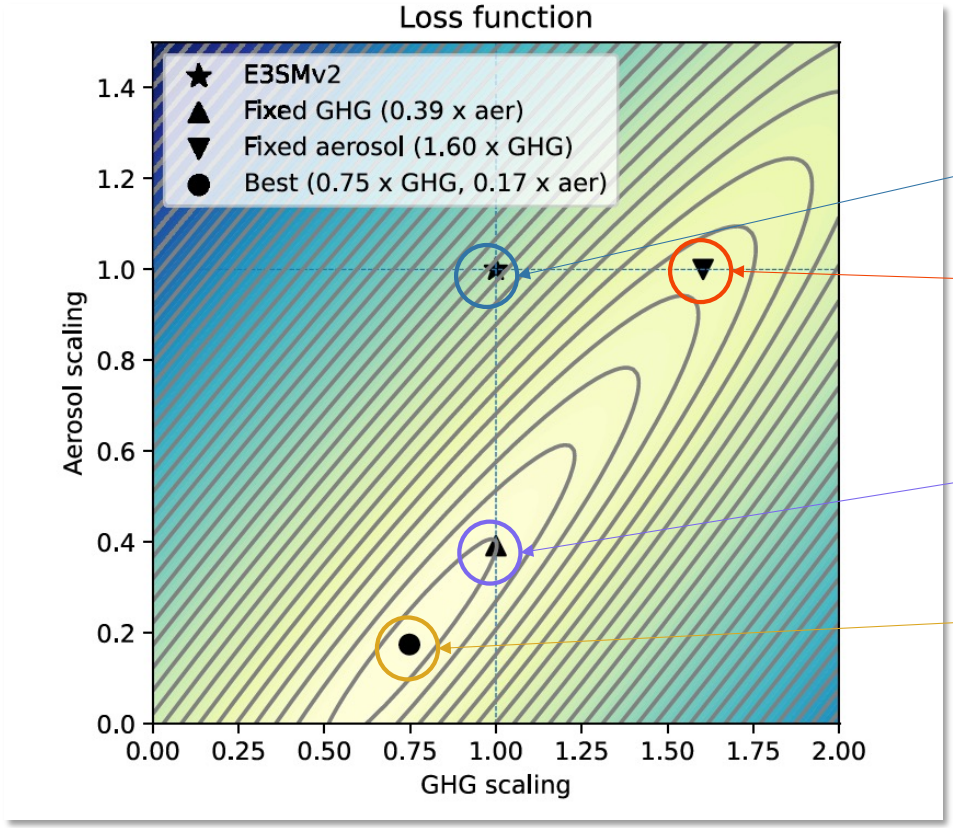
Meehl, et al (2008)

Single forcing ensemble

- Treating single-forcing simulations as linear perturbations from the piControl, we can recompose them with alternate strengths:
- Modulate strength of GHG response (proxy for TCR/ECS) and aerosol related to create alternate **composite configurations**.
- Applicable to any field; linear approximation holds well.



Looking for an optimum



Weaker aerosol-related impact

Weaker GHG impact (proxy for TCR/ECS)

E3SMv2

holding aerosol

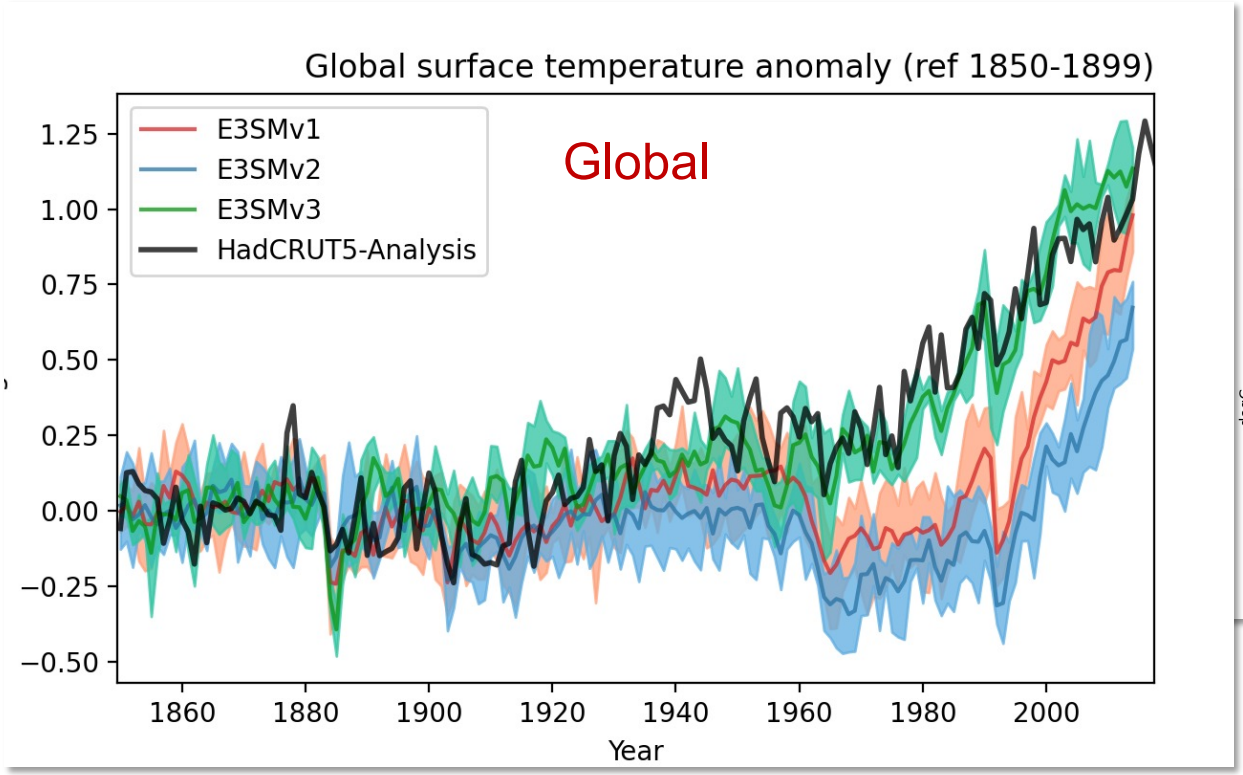
holding GHG

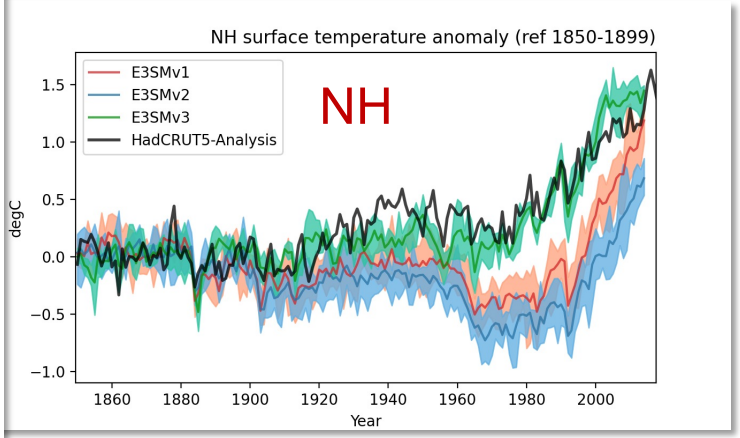
best

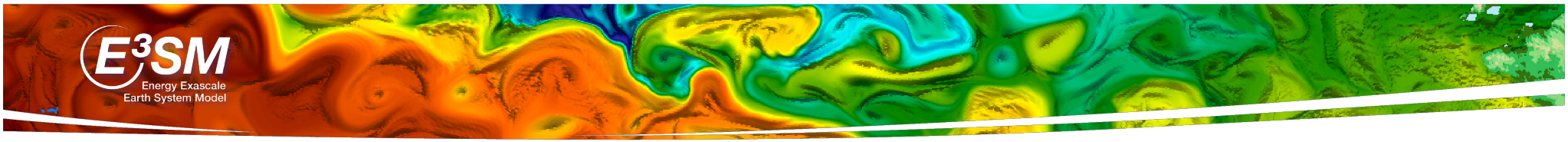
Golaz et al. (2022)

E3SMv3: fixing the pothole

Historical temperature ("Third time's a charm")







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